

We claim:

1. An isolated nucleic acid sequence coding for a polypeptide having acyl-CoA:lysophospholipid-acyltransferase activity, wherein the acyl-CoA:lysophospholipid acyltransferase encoded by said nucleic acid sequence specifically converts C<sub>16</sub>, C<sub>18</sub>-, C<sub>20</sub>- or C<sub>22</sub>- fatty acids having at least one double bond in the fatty acid molecule.
2. The isolated nucleic acid sequence according to claim 1, selected from the group consisting of:
  - a) a nucleic acid sequence having the sequence depicted in SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 5 or SEQ ID NO: 7,
  - b) nucleic acid sequences which can be derived from the coding sequence comprised in SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 5 or SEQ ID NO: 7 as a result of the degenerated genetic code,
  - c) derivatives of the nucleic acid sequence depicted in SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 5 or SEQ ID NO: 7 which code for polypeptides having the amino acid sequence depicted in SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6 or SEQ ID NO: 8 and are at least 40% homologous at the amino acid level to SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6 or SEQ ID NO: 8 and have an acyl-CoA:lysophospholipid-acyltransferase activity.
3. The isolated nucleic acid sequence according to claim 1 or 2, which is derived from a eukaryote.
4. An amino acid sequence encoded by an isolated nucleic acid sequence according to any of claims 1 to 3.
5. A gene construct comprising an isolated nucleic acid according to any of claims 1 to 3, wherein said nucleic acid is functionally linked to one or more regulatory signals.
6. The gene construct according to claim 5, wherein the nucleic acid construct comprises additional biosynthetic genes of the fatty acid or lipid metabolism, selected from the group consisting of acyl-CoA dehydrogenase(s), acyl-ACP[= acyl carrier protein]. desaturase(s), acyl-ACP thioesterase(s), fatty acid acyltransferase(s), fatty acid synthase(s), fatty acid hydroxylase(s), acetyl-coenzyme A carboxylase(s), acyl-coenzyme A oxidase(s), fatty acid desaturase(s), fatty acid acetylenases, lipoxygenases, triacylglycerol lipases, allenoxide synthases, hydroperoxide lyases or fatty acid elongase(s).
7. The gene construct according to claim 5 or 6, wherein the nucleic acid construct

comprises additional biosynthetic genes of the fatty acid or lipid metabolism, selected from the group consisting of  $\Delta 4$ -desaturase,  $\Delta 5$ -desaturase,  $\Delta 6$ -desaturase,  $\Delta 8$ -desaturase,  $\Delta 9$ -desaturase,  $\Delta 12$ -desaturase,  $\Delta 5$ -elongase,  $\Delta 6$ -elongase or  $\Delta 9$ -elongase.

- 5     8.     A vector comprising a nucleic acid according to claims 1 to 3 or a gene construct according to claims 5 to 7.
9.     A transgenic nonhuman organism comprising at least one nucleic acid according to claims 1 to 3, a gene construct according to claims 5 to 7 or a vector according to claim 8.
- 10    10.    The transgenic nonhuman organism according to claim 9, which organism is a microorganism, a nonhuman animal or a plant.
11.    The transgenic nonhuman organism according to claim 9 or 10, which organism is a plant.
- 15    12.    A process for producing polyunsaturated fatty acids in an organism, wherein said process comprises the following steps:
  - a)     introducing into the organism at least one nucleic acid sequence having the sequence depicted in SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 5 or SEQ ID NO: 7, which sequence codes for a polypeptide having an acyl-CoA:lysophospholipid-acyltransferase activity; or
  - 20       b)     introducing into said organism at least one nucleic acid sequence which can be derived, as a result of the degenerated genetic code, from the coding sequence comprised in SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 5 or SEQ ID NO: 7, or
  - 25       c)     introducing into said organism at least one derivative of the nucleic acid sequence depicted in SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 5 or SEQ ID NO: 7, which code for polypeptides having the amino acid sequence depicted in SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6 or SEQ ID NO: 8 and which are at least 40% homologous at the amino acid level to SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6 or SEQ ID NO: 8 and have an equivalent acyl-CoA:lysophospholipid-acyltransferase activity, and
  - 30       d)     culturing and harvesting said organism.
- 35    13.    A process for producing polyunsaturated fatty acids according to claim 12, wherein, in addition to the nucleic acid sequences mentioned under (a) to (c), further nucleic acid sequences have been introduced into said organism, which code for polypeptides of the fatty acid or lipid metabolism, selected from the group consisting of acyl-CoA-dehydrogenase(s), acyl-ACP[= acyl carrier protein] desaturase(s), acyl-ACP thioesterase(s), fatty acid acyltransferase(s), fatty acid

synthase(s), fatty acid hydroxylase(s), acetyl-coenzyme A carboxylase(s), acyl-coenzyme A oxidase(s), fatty acid desaturase(s), fatty acid acetylenases, lipoxygenases, triacylglycerol lipases, allenoxide synthases, hydroperoxide lyases or fatty acid elongase(s).

- 5 14. The process for producing polyunsaturated fatty acids according to claim 12 or 13, wherein, in addition to the nucleic acid sequences mentioned under (a) to (c), further nucleic acid sequences have been introduced into the organism, which code for polypeptides selected from the group consisting of  
10  $\Delta 4$ -desaturase,  $\Delta 5$ -desaturase,  $\Delta 6$ -desaturase,  $\Delta 8$ -desaturase,  $\Delta 9$ -desaturase,  $\Delta 12$ -desaturase,  $\Delta 5$ -elongase,  $\Delta 6$ -elongase or  $\Delta 9$ -elongase activity.
- 15 15. The process for producing polyunsaturated fatty acids according to claims 12 to 14, wherein  $C_{16}$ -,  $C_{18}$ -,  $C_{20}$ - or  $C_{22}$ - fatty acids are used as substrate of the acyl-CoA:lysophospholipid acyltransferases.
- 16 16. The process for producing polyunsaturated fatty acids according to claims 12 to 15, wherein the polyunsaturated fatty acids are isolated from the organism in the form of an oil, lipid or a free fatty acid.
17. The process for producing polyunsaturated fatty acids according to claims 12 to 16, wherein the polyunsaturated fatty acid produced in said process is a  $C_{18}$ -,  $C_{20}$ - or  $C_{22}$ - fatty acids having at least two double bonds in the molecule.
- 20 18. The process for producing polyunsaturated fatty acids according to claims 12 to 17, wherein a polyunsaturated fatty acid selected from the group consisting of dihomo- $\gamma$ -linolenic acid, arachidonic acid, eicosapentaenoic acid, docosapentaenoic acid and docosahexaenoic acid is produced in said process.
- 25 19. The process for producing polyunsaturated fatty acids according to claims 12 to 18, wherein the organism is a microorganism, a nonhuman animal or a plant.
20. The process for producing polyunsaturated fatty acids according to claims 12 to 19, wherein the organism is a transgenic plant.
21. The process for producing polyunsaturated fatty acids according to claims 12 to 20, wherein the transgenic plant is an oil crop plant.
- 30 22. An oil, a lipid or a fatty acid or a fraction thereof, prepared by the process according to any of claims 12 to 21.
23. An oil composition, a lipid composition or a fatty acid composition which comprises polyunsaturated fatty acids prepared by a process according to any of claims 12 to 21 and is derived from transgenic plants.

24. The use of oil, lipids or fatty acids prepared by a process according to any of claims 12 to 21 or an oil composition, lipid composition or fatty acid composition according to claim 23 in feed, foodstuffs, cosmetics or pharmaceuticals.